GASES

What is **pressure**?

A **barometer** is an instrument that measures atmospheric pressure.

Standard pressure is the pressure at sea level. What are the values for standard pressure given the following units??

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_atm(atmospheres), \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_kPa(kilopascals), \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_mmHg(mm of mercury)

State **Boyle’s Law**:

The formula for Boyle’s law is  **p1v1= p2v2**

What does the “p” stand for? What units?

What does the “v” stand for? What units?

What does the “1” mean?

What does the “2” mean?

What is held constant and doesn’t change in Boyle’s law?

Draw a graph of Boyle’s law. Hint: It is an inversely proportional graph. Don’t forget to label the axis and include plausible units.

So, for example, if p1 is 822 kPa, v1 is 312 cm3 , p2 is 948 kPa, and v2 = ?

The set up is (822 kPa) (312 cm3) = (948 kPa) (v2) notice the units match up!!

V2 = 271 cm3

Practice problem:

Some oxygen occupies 250 ml when the barometer reads 100 kPa. How many kPa will it occupy when the volume is reduced to 240 ml? (104.17 kPa)

State **Charles’s Law**:

The formula for Charles’s law is **v1t2 = v2t1**

What does the “v” stand for? What units?

What does the “t” stand for? What units?

What units MUST “t” be in? How do you convert from Celcius to Kelvin?

What does the “1” mean?

What does the “2” mean?

Draw a graph of Charles’s law. Hint: It is a directly related graph. Don’t forget to label the axis and include plausible units.

So, for example, if v1 is 152 cm3 , t1 is 18°C, v2 is ? , and t2 is 32°C

The set up is (152 cm3) (305 K) = (v2) (291 K) notice the units must match up and are changed to Kelvin

V2 = 159 cm3

Practice problem:

The volume of a gas is 1164 ml at 18°C. What is its volume at standard temperature?

(1092 ml)

State the **Combined(Mixed) Gas Law**

The formula is **v1p1t2 = v2p2t1**

Why is it called the combined gas law?

What does the “v” stand for? What units?

What does the “p” stand for? What units?

What does the “t” stand for? What units?

What does the “1” mean?

What does the “2” mean?

What does STP stand for? What are their values with units?

So, for example, if v1 is 205 cm3 , p1 is 30.8 kPa, t1 is 22.0°C, v2 =?, p2 is standard, t2 is standard.

The set up is (205 cm3) (30.8 kPa) (273 K) = v2 (101.325 kPa) (295 K)

V2 = 57.7 cm3

Practice problem:

A gas collected when the temperature is 20°C and the pressure is 200 kPa measures 425 ml. Calculate the volume at STP. (781.62 ml)

Define **diffusion**-

State **Graham’s Law**

The formula is **v1 / v2 = √ (m2 / m1)**

What does the “v” stand for? What units?

What does the “m” stand for? What units?

Sometimes the v is replaced with a “r”. What does that mean?

For example, What is the ratio between hydrogen gas and oxygen gas and their diffusion rates?

The set up would be: r1 / r2 = √ (m2 / m1) rH2 / rO2 = √ (32/ 2)

So, rH2 / rO2 = 4 / 1

What does that answer mean? Which gas moves faster? Which gas is lighter? Which gas is heavier?

Practice problem:

What is the ratio of the speed of helium atoms to nitrogen molecules when both gases are at the same temperature? (Remember that nitrogen is diatomic)

State the **Ideal Gas Law**

The formula is **pV = nRT**

What does the “p” stand for? What units?

What does the “V” stand for? What units?

What does the “n” stand for? What units?

What does the “R” stand for? What units? Give 2 values that R could be with units.

kPa L/ mol K or atm L/ mol K

What does the “T” stand for? What units?

Notice that you need to be very careful about units with this formula.

Also, notice that just like cm3 is the same as ml. So is dm3 the same as L.

So, for example, If 15 grams of CO is at STP, what would its volume be?

The set up would be:

(101.325 kPa) (v) = (15 g CO/1 x 1 mol/ 28.01 g CO) (8.31 kPa L/mol K) (273 K)

OR

(1 atm) (v) = (15 g CO/1 x 1 mol/ 28.01 g CO) (.0821 atm L/mol K) (273 K)

v = 12.0 L

Practice problem:

What volume must be maintained to ensure that 2.1 atm of a 0.75 mole gas at -10°C is stable? (7.71 L or dm3)

State **Gay-Lussac’s Law**:

The formula for Gay-Lussac’s law is  **p1t2= p2t1**

What does the “p” stand for? What units?

What does the “t” stand for? What units?

What does the “1” mean?

What does the “2” mean?

What is held constant and doesn’t change in Gay-Lussac’s law?

Draw a graph of Gay-Lussac’s law. Hint: It is a directly related graph. Don’t forget to label the axis and include plausible units.

So, for example: It the temperature is 23°C and the pressure is standard. What will be the temperature if the pressure is raised to 780 mmHg?

**p1t2= p2t1** (760mmHg)(t2) = (780mmHg)(273.15 + 23 K = 296.15 K)

t2 = 303.94 K

Practice problem:

If under standard temperature and pressure, the conditions are changed so the temperature is now 50°C, what will be the new pressure?

Do this problem three different ways by comparing/contrasting atm, kPa, and mmHg

What is **molar volume**? What is the molar volume value with units?

Note you can only use the molar volume value under standard conditions.

For example: Calculate the mass of 5 Liters of ammonia, NH3, at STP:

(5 L/1) x (1mol/22.414 L) x (17.04g/1mole) = 3.80 g NH3

Practice problem 1: Calculate the density of ammonia at STP

Practice problem 2: If the density of an unknown gas is 1.34 g/L at STP, calculate it’s molecular mass in g/mol.

THINK QUESTIONS:

1. Why do you need to bake a cake for a longer period of time or at a higher temperature when you are at high altitudes, like Denver, Colorado?

2. How does a pressure cooker work?

3. Why do scuba divers need to be careful when they are resurfacing from deep in the ocean?

4. Why does a helium balloon pop when it is let go and goes up in the sky?

5. Whey do they say not to put an aerosol can in a closed car in the summer time?

6. What allows you to suck up a liquid with a straw?

7. What allows you to be able to ice skate?